

(No Model.)

7 Sheets—Sheet 1.

C. D. MOSHER.  
STEAM GENERATOR.

No. 432,760.

Patented July 22, 1890.

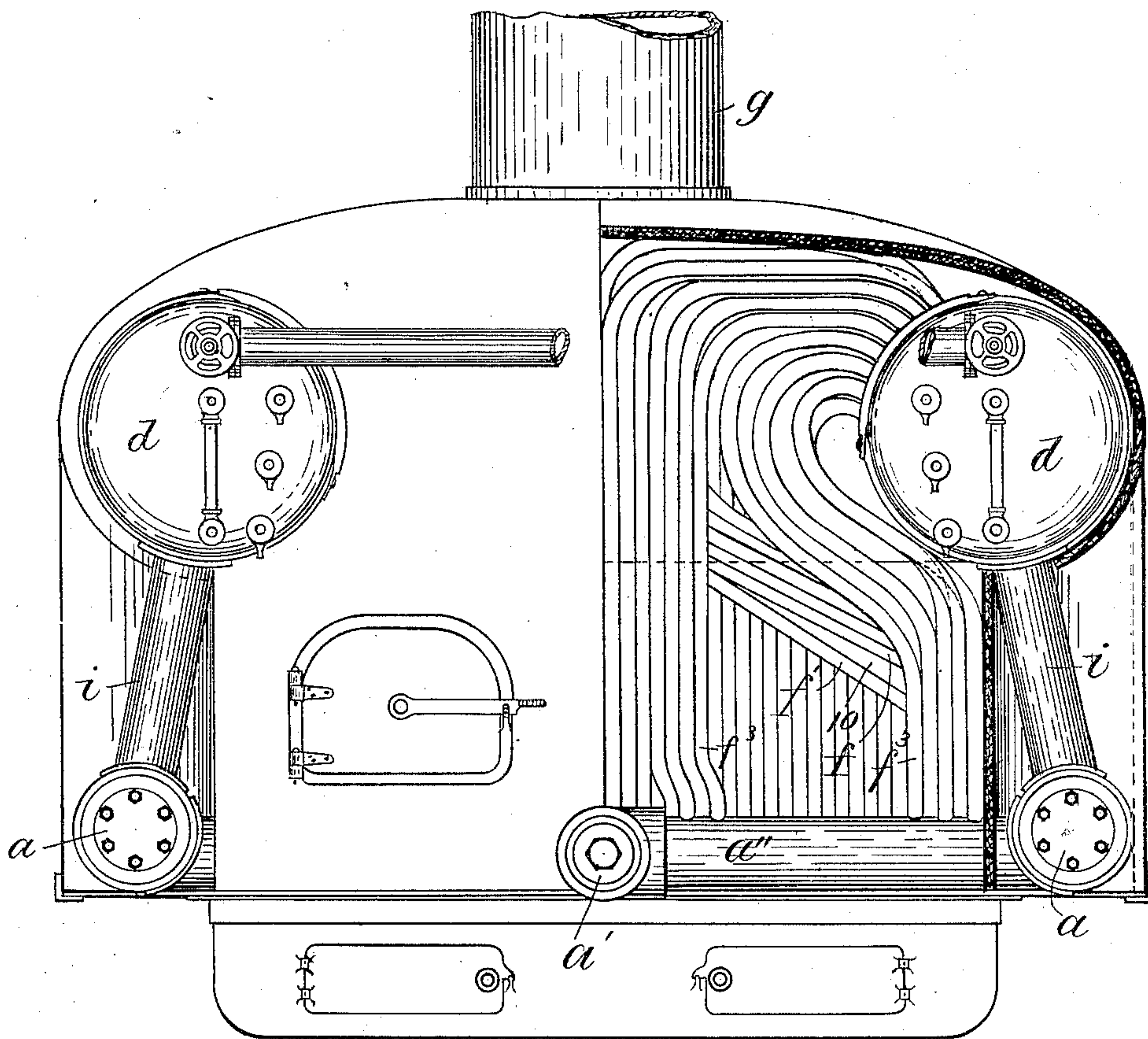


Fig. 1

WITNESSES

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Swing J. Stankler

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Wm. B. Brown  
Atty.

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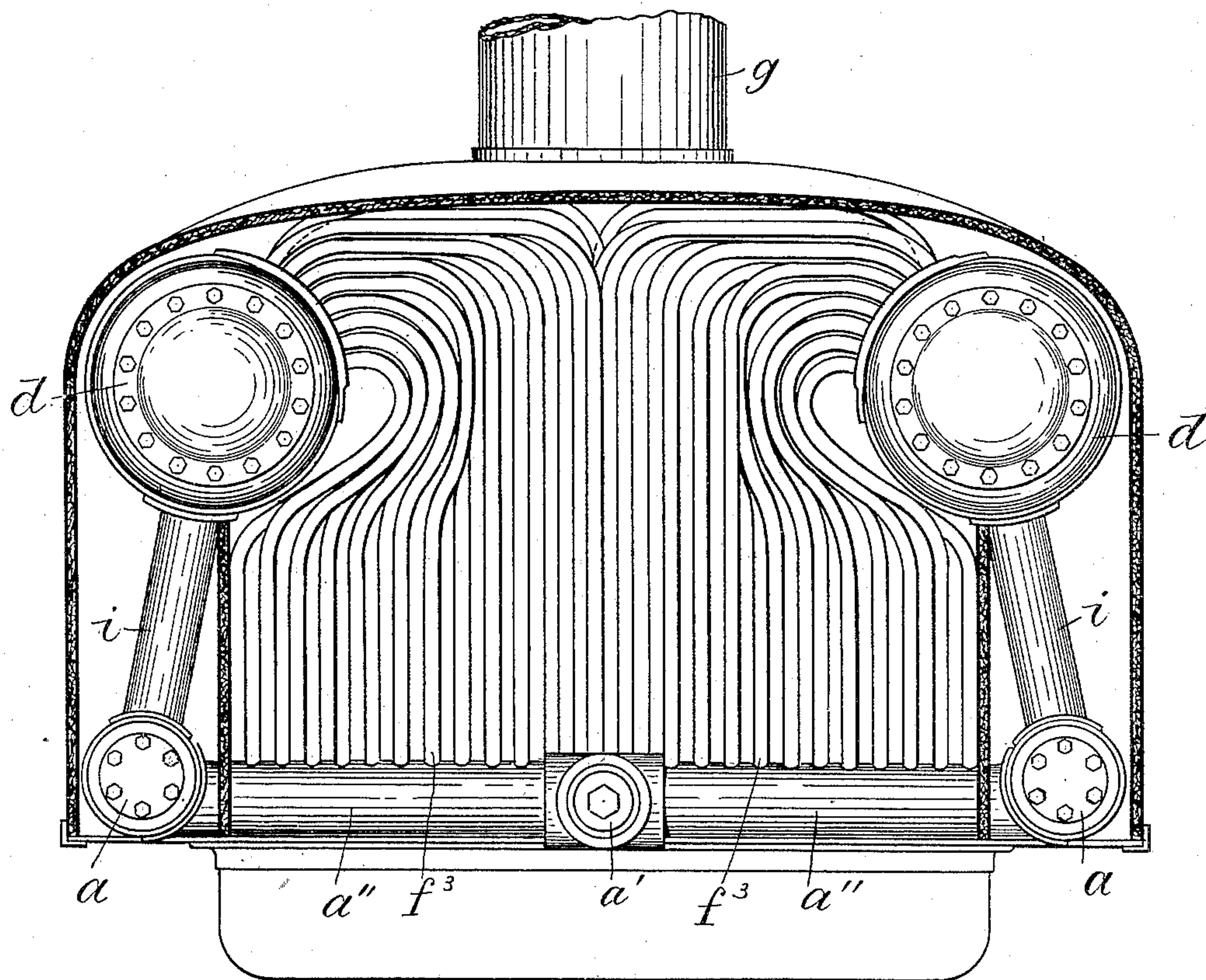


Fig. 1<sup>a</sup>

WITNESSES

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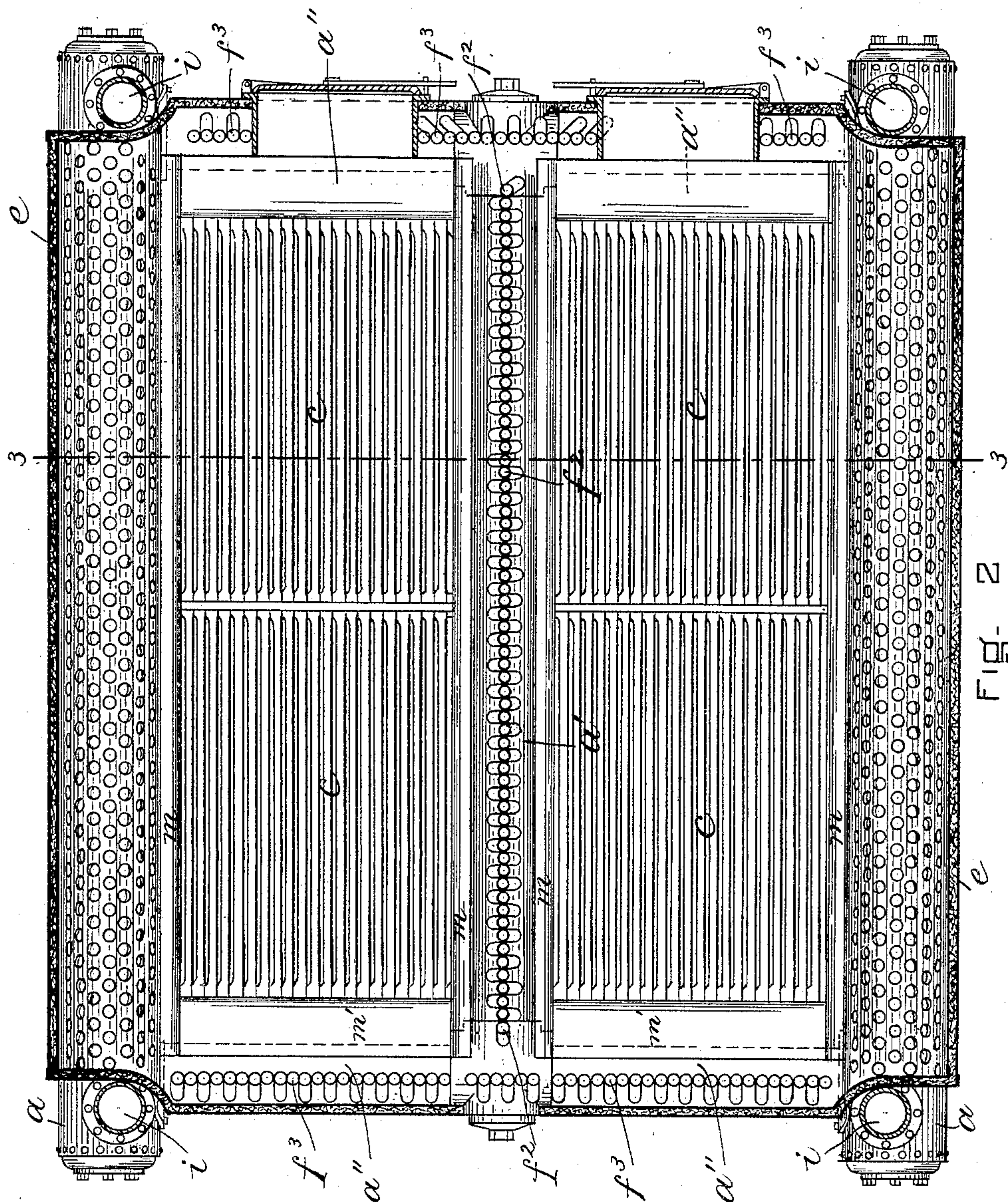


FIG- 2

WITNESSES

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(No Model.)

7 Sheets—Sheet 4.

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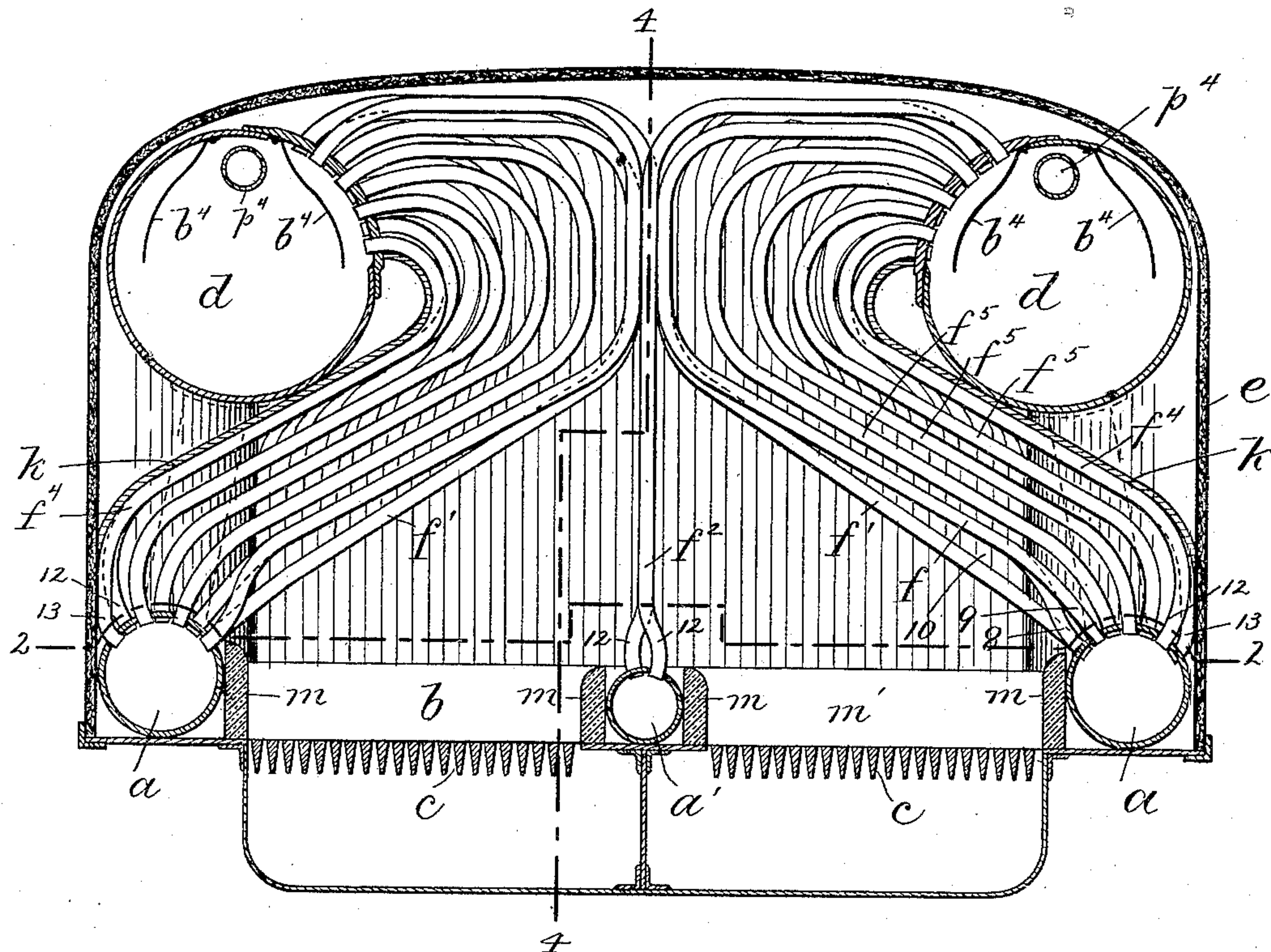


Fig. 3

WITNESSES

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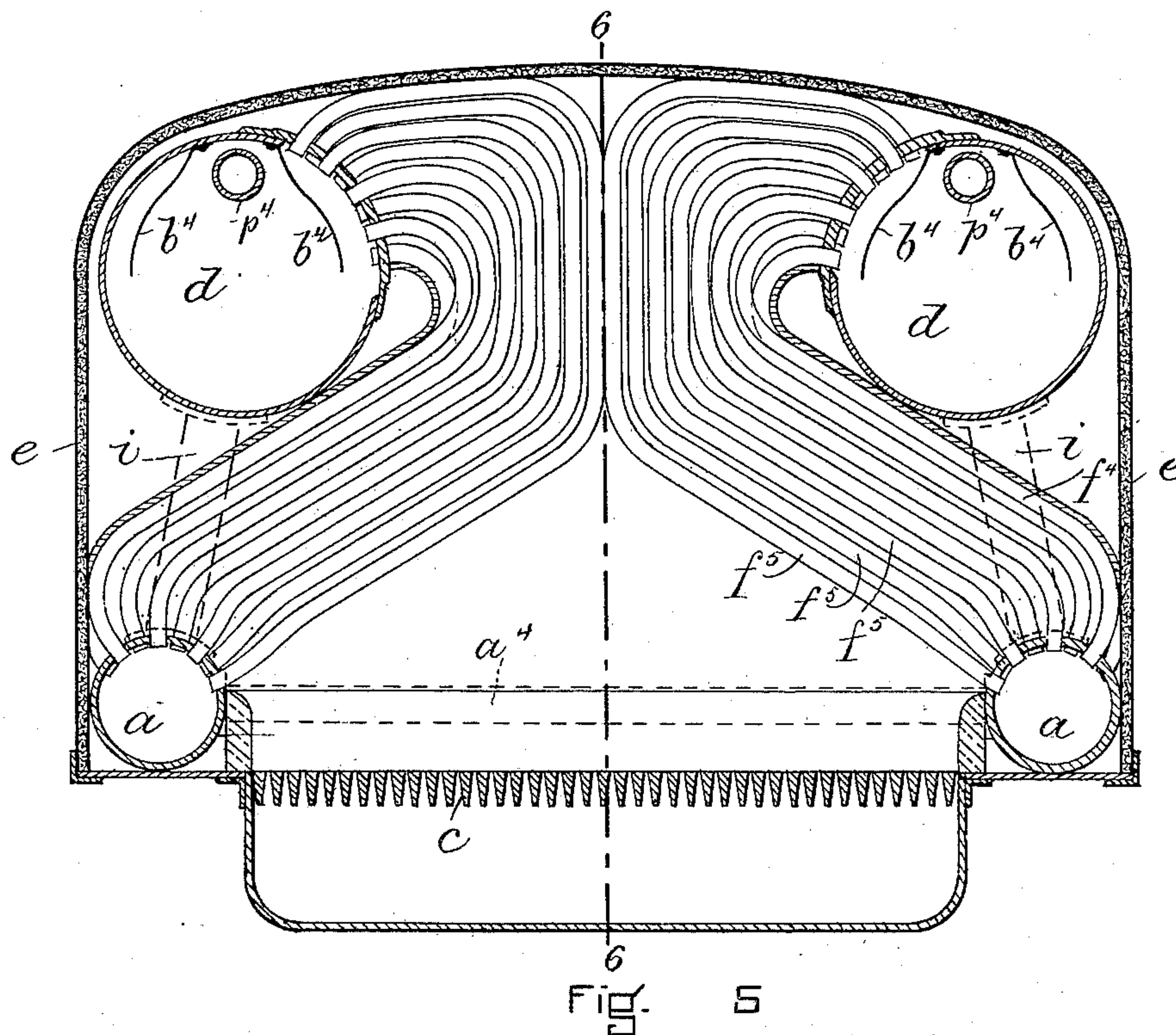
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C. D. MOSHER.  
STEAM GENERATOR.

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Patented July 22, 1890.



WITNESSES.  
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(No Model.)

7 Sheets—Sheet 7.

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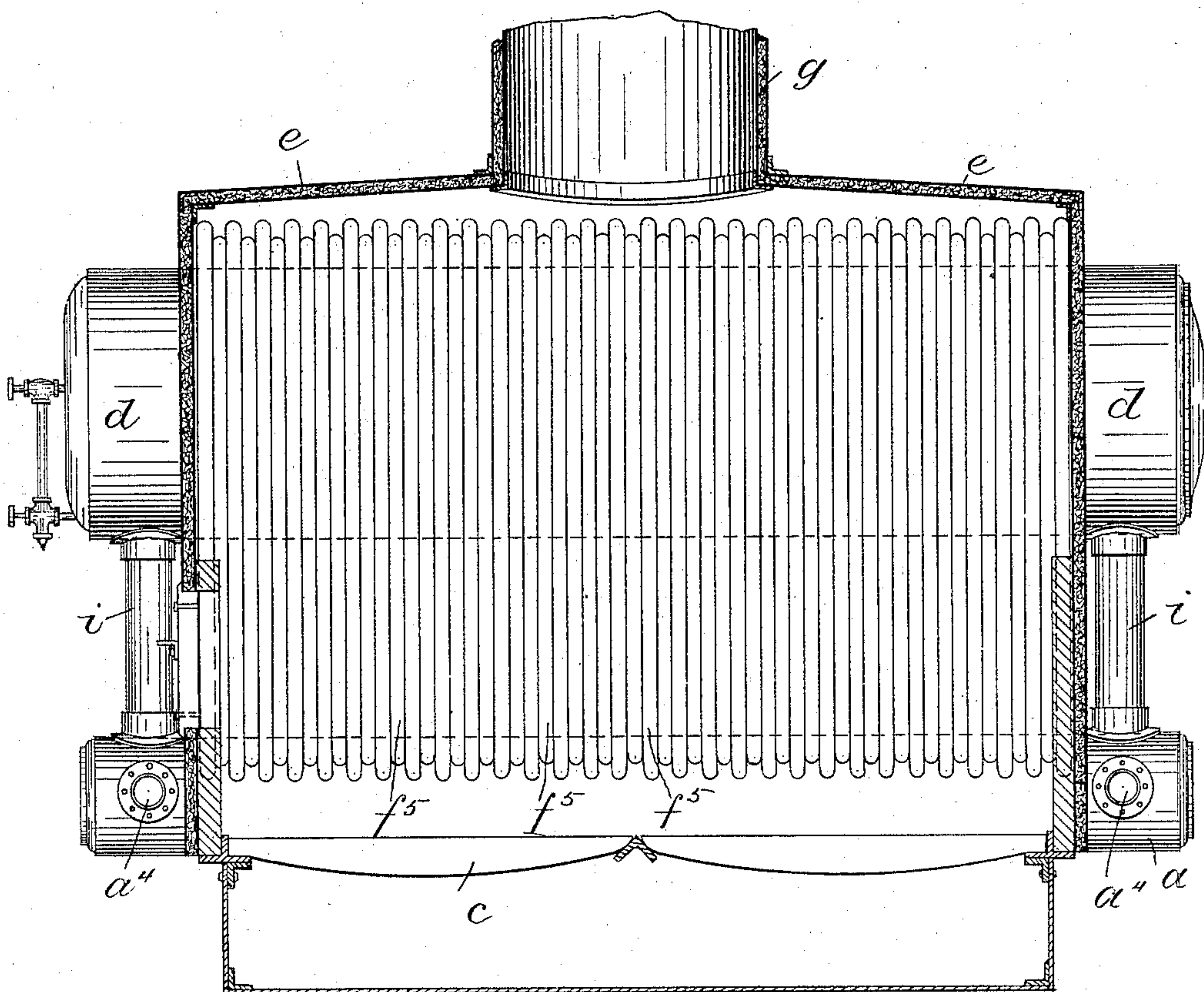


Fig. 6

WITNESSES.

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Ernest W. Harrison.

INVENTOR.

C. D. Mosher

By Wm. B. Brown Clerk

Atty.



# UNITED STATES PATENT OFFICE.

CHARLES D. MOSHER, OF AMESBURY, MASSACHUSETTS.

## STEAM-GENERATOR.

SPECIFICATION forming part of Letters Patent No. 432,760, dated July 22, 1890.

Application filed March 15, 1890. Serial No. 344,040. (No model.)

*To all whom it may concern:*

Be it known that I, CHARLES D. MOSHER, of Amesbury, in the county of Essex and State of Massachusetts, have invented certain new and useful Improvements in Steam-Generators, of which the following is a specification.

This invention relates to steam-generators in which horizontal water receptacles or drums situated at or near the level of the fire-box or furnace-grate are connected by bent generating-tubes with steam-drums located above the water-drums, the generating-tubes between the said receptacles being exposed to the fire.

The invention has for its object to provide a generator of this class having a low center of gravity, a high combustion-chamber, large areas of water surfaces or level, and, in general, to provide a generator of great efficiency, lightness, durability, and simplicity of construction, and adapted by the principle of its construction for use in steam launches, yachts, and marine use in general.

To these ends the invention consists in the improvements, which I will now proceed to describe and claim.

Of the accompanying drawings, forming a part of this specification, Figure 1 represents an end elevation of my improved steam-generator, a portion of the front of the casing being removed to show the interior. Fig. 1<sup>a</sup> represents an elevation from the opposite end, the entire end of casing being removed. Fig. 2 represents a horizontal section taken on line 2 2, Fig. 3. Fig. 3 represents a transverse section on line 3 3, Fig. 2. Fig. 4 represents a vertical section on line 4 4, Fig. 3. Fig. 5 represents a transverse section of a modification; and Fig. 6 represents a section on line 6 6, Fig. 5.

The same letters of reference indicate the same parts in all of the figures.

In the drawings, *a a* represent two horizontal water-drums, which are arranged substantially parallel with each other at opposite sides of the fire-chamber or furnace *b*, said drums being at or just above the level of the grate or grates *c* of the furnace, the latter being shown in Figs. 1 and 2 as divided into two sections and having two grates, while in Fig.

5 it is shown without division and having one grate.

*d d* represent two steam-drums, which are arranged above the water-drums *a a* and practically outside the space which constitutes the fire-box of the furnace, each steam-drum being located nearly or quite above a water-drum, although the centers of the steam-drums are here shown as inside the vertical plane of the centers of the water drums, this arrangement being adopted because it is preferred to arrange the outer sides of the steam-drums directly over the outer sides of the water-drums to accommodate the casing *e*, which incloses the whole apparatus, the steam-drums being of larger diameter than the water-drums, so that their inner sides project inwardly farther than the inner sides of the water-drums.

Each water-drum is connected with the steam-drum above it by a series of bent steam-generating tubes *f f' f<sup>4</sup> f<sup>5</sup>*. There are a large number of these tubes, and their lower ends are connected with the upper portions of the water-drums. From the points of connection with the water-drums the said tubes are bent inwardly and upwardly toward the center and upper portion of the furnace, and are then bent outwardly until they join the inner sides of the steam-drums.

It will be seen that the tubes *f, f', f<sup>4</sup>, and f<sup>5</sup>* are formed and arranged to expose their contents in the most favorable manner to the heat of the furnace, and at the same time enable the steam-drums *d* to be located at a minimum height above the water-drums *a*, thus giving the generator a low center of gravity, and making it in this respect particularly desirable for steam launches and yachts and other craft in which economy of vertical space is desirable in the steam-generator. It will also be seen that the employment of two steam-drums is essential to the above arrangement of the tubes, because if a single steam-drum were employed the pipes could not be disposed in the manner shown, so as to permit said drum to be at a minimum height above the water-drums, and at the same time expose the tubes advantageously to the fire, because if the tubes were arranged



as here shown—that is to say, extending at an incline toward the center and upper portion of the furnace and then curved outwardly to enter the upper portion of the steam-drum—the generator would not be evenly balanced, but would be heaviest on the side toward which the tubes are inclined as they leave the water-drum.

The form of the tubes here shown and the duplicate steam-drums, which are enabled by the form of the tubes to be brought down comparatively close to the water-drums, are both essential to the production of a steam-generator having a low center of gravity, which is an important feature of my invention. The arrangement of the inner tubes  $f$  is such that said tubes along the forward portion of the furnace, or from that end which contains the fire-doors nearly to the opposite end, constitute a practically-closed wall made up of the inclined portions of said tubes, said inclined portions being parallel with each other, and arranged so that each is practically in contact with the next, so that collectively said inclined portions form an inclined wall or diaphragm between the portions of the furnace immediately over the grate and the steam-drums. Said wall or diaphragm is composed of the tubes, the lower ends of which constitute the two inner rows at the points where they join the water-drums, and the said tubes are caused to form close walls by the bending of every alternate tube upward, as shown at 8 in Fig. 3, to bring it in line with the tubes of the next row at points just above the lower ends 9 of the last-named tubes. The object of arranging the tubes to form a close wall, as described, is to cause the heated products of combustion from the furnace to pass from the front toward the rear end of the furnace before passing outside of the inner tubes which form said wall. To enable the products of combustion to pass between the tubes at the rear end of the furnace, I give each tube of the inner row a substantially straight form, the said straight tubes being marked  $f'$  in Figs. 1, 3, and 4, their straight form creating the spaces 10 between the said tubes  $f'$  and the intermediate tubes  $f$ , said spaces 10 permitting the products of combustion to pass outwardly, as indicated by the arrows in Fig. 4, into the rear portion of the space between the walls composed of the tubes  $f$  and an outer wall composed of tubes  $f^4$ , placed next the casing  $k$ . The tubes  $f^4$  are those which, in springing from the water-drums, constitute the two outer rows, their lower ends being marked 12 13 in Fig. 3. The wall composed of the tubes  $f^4$  extends the entire length of the furnace and protects the inner and under sides of the steam-drums  $d$  from the action of the fire. The spaces between the said inner and outer walls of tubes contain the tubes  $f^5$ , which are of the same general form as the tubes  $f$  and  $f^4$ , but are separated, so that the products of combustion pass freely around each tube.

The smoke-stack  $g$  is arranged over the forward end of the furnace, as shown in Fig. 4, so that the products of combustion, after passing through the spaces 10, are caused to travel in the opposite direction toward the forward end of the furnace, as indicated by the dotted arrows in Fig. 4, the tubes being thus exposed to the action of the heat.

I prefer to place a baffle-plate or deflector  $h$  across the upper portion of the furnace, just in the rear of the smoke-stack, as shown in Fig. 4, so that the products of combustion must take a downward course, as indicated by the dotted arrows, before reaching the smoke-stack, said deflector preventing the too direct escape of the products of combustion and causing the same to act more fully upon the water in the tubes.

It will be seen that by the described arrangement of the tubes each tube of the many which compose the series is exposed to the action of the heat, said arrangement constituting another important feature of my invention.

The ends of the steam-drums are connected with the ends of the water-drums by pipes  $i$  for the return of water from the steam-drums to the water-drums. Said return-pipes are located outside of the casing  $e$ , as best shown in Fig. 2, so that they are not subjected to the heat within the casing, but are kept comparatively cool by contact with the external air; hence the descent of water through the said return-pipes to the water-drums is facilitated, as will be readily seen.

There are two return-pipes for each steam-drum, and said pipes, besides maintaining a uniform circulation, support each drum at both ends, so that there is no opportunity for either end to sag or be depressed.

In the construction shown in Figs. 1, 2, 3, and 4 the furnace is subdivided or partially subdivided by an intermediate water-drum  $a'$ , located at the center of the fire-box and just above the grate, and a row of tubes  $f^2$ , extending upwardly from the said water-drum and arranged so that above their bent ends they form a close wall extending lengthwise of the furnace, the upper portions of said tubes  $f^2$  being curved outwardly, and every alternate tube extended over to the steam-drum at the one side of the furnace and the remaining tubes over to the steam-drum at the other side of the furnace. The intermediate drum  $a'$  is connected by transverse pipes  $a''$  with the outside water-drums  $a$ , so that water from the drums  $a$  enters the drum  $a'$  and passes upwardly therefrom through the tubes  $f^2$ , said tubes exposing the water to heat at the center of the furnace, and thereby increasing the power of the generator.

I prefer to connect tubes  $f^3$  with the transverse pipes  $a''$ , said tubes  $f^3$  extending upwardly and being curved at their upper ends and joined to the steam-drums, as indicated in Fig. 4. Said tubes  $f^3$  spring from the pipes



$a''$  in two rows, those of the outer row being bent inwardly, as shown at 14, Fig. 4, so that the tubes  $f^3$  constitute closed vertical end walls, which are interrupted at the front ends 5 of the furnace by the spaces for the fire-doors.

It will be observed that the steam-drums are protected from the direct action of the fire by the interposed tubes, so that they can be affected only by the radiation of heat from 10 the hot gases and products of combustion that pass through the spaces 10 at the rear portion of the fire-box; hence liability of burning or injuring the drums by overheating their surfaces is reduced to a minimum. As 15 an additional protection to the steam-drums, I prefer to interpose partitions  $k$  between the lower portions of said drums and the furnace, as shown in Fig. 3, said partitions being curved and inclined, as shown in said 20 figure.

The products of combustion pass to the stack  $g$  through openings formed between the tubes  $f$  and  $f^2$ , the latter being raised above the tubes  $f$  forward of the deflector  $h$ , as shown 25 in Fig. 4, so that spaces exist between the horizontal portions of said tubes  $f$   $f^2$  of sufficient width to permit the passage of the smoke and gases to the stack. The horizontal or approximately horizontal portions of the tubes 30  $f$   $f^2$  are arranged side by side at the rear of the deflector  $h$ , as shown in Fig. 4, so that they constitute closed walls at the top of the space or flue containing the tubes  $f^5$ .

In addition to the advantages hereinbefore 35 mentioned the following may be named: First, the combustion-chamber or the space inclosed by the walls formed by the tubes  $f$   $f'$  is higher in proportion to the total height of the boiler or generator than it could be 40 without the employment of the two steam-drums and the peculiar arrangement of the tubes here shown; secondly, the tubes connecting the water-drums with the steam-drums are enabled to be formed with less 45 abrupt bends, so that the water can circulate easily and freely through them; third, by the employment of the two steam-drums  $d$   $d$  instead of one, a large area of water-level as compared with the total quantity of water 50 carried is obtained, so that sudden lowering of water-level in the boiler when the supply of feed-water is interrupted is prevented.

The water-drums are protected from contact with the fuel in the furnaces by fire-brick 55 linings  $m$ , and the transverse connecting-pipes  $a''$  are protected by similar linings  $m'$ .

The water-drums act also as mud-drums, and should have suitable blow-off cocks and hand-holes to allow of the removal of de- 60 posits.

The tubes  $f$ ,  $f'$ ,  $f^2$ ,  $f^3$ ,  $f^4$ , and  $f^5$  are connected with the drums and pipes by inserting the ends of the tubes into orifices in the drums and pipes, and then by special tools, 65 which I have devised, expanding said ends within the orifices.

Figs. 5 and 6 show a single grate and an

undivided fire-box over the same, the central drum  $a'$ , the tubes  $f^2$  thereto connected, and the end tubes  $f^3$  being omitted. The inner wall 70 composed of the tubes  $f$  is also omitted, while the outer wall composed of the tubes  $f^4$  is retained, the other tubes  $f^5$  being all separated from each other.

Pipes  $a^4$   $a^4$  are shown as connecting the 75 drums  $a$  outside the casing.

$b^4$   $b^4$ , Fig. 3, represent deflectors or baffle-plates, which are attached to the upper portions of the inner surfaces of the steam-drums  $d$  at opposite sides of perforated dry-pipes  $p^4$ , 80 which extend through the drums and are connected outside thereof with pipes which conduct the steam to the engine. Said baffle-plates are curved downwardly and are formed to prevent the water in the drums from en- 85 tering the dry-pipes when the water is put in motion by the movements of the craft or vessel. Each inner baffle-plate is interposed between the dry-pipe and the upper ends of the generating-tubes, so that in case any water 90 should be carried into the steam-drums with the steam by said tubes such water cannot enter the dry-pipe.

The baffle-plates are independent of each other and are attached to the drum at oppo- 95 site sides of the space between the dry-pipe and the top of the drum. This construction and arrangement of the baffle-plates permits the dry-pipe to be placed close to the top of the steam-drum, thereby insuring a better 100 quality of steam than if it were placed lower in the drum, and also enables the steam-pipe connection with the drum to be made through the top of the drum without interference with the baffle-plates. 105

I claim—

1. In a steam-generator, the combination of two water-drums arranged at opposite sides of the furnace, two steam-drums arranged above said water-drums at opposite sides of 110 the fire-space of the furnace, and bent generating-tubes connecting the water-drums with the steam-drums, said tubes being inclined inwardly and upwardly toward the center and upper portion of the furnace and then bent 115 outwardly from the center of the furnace and joined to the steam-drums above the water-lines thereof, whereby space is afforded outside of the tubes and above the water-drums for the steam-drums, the latter being thus lo- 120 cated so near the water-drums as to give a low center of gravity, as set forth.

2. In a steam-generator, the combination of two water-drums arranged at opposite sides of the grate, two steam-drums arranged over 125 said water-drums, the series of bent tubes connecting the water-drums with the steam-drums and arranged as shown, and two return water-pipes connecting the ends of each steam-drum with the ends of the correspond- 130 ing water-drum outside of the casing of the furnace, said return-pipes maintaining a uniform circulation and supporting both ends of each steam-drum, as set forth.



3. In a steam-generator, the combination of the water-drums arranged at opposite sides of the grate, the steam-drums arranged over said water-drums, the tubes  $f f'$ , connecting  
 5 the water and steam drums and arranged to constitute a closed inner wall extending from the front partly to the rear end of the furnace, the said tubes  $f'$  alternating with the tubes  $f$  near the rear portion of the furnace, the tubes  
 10  $f'$  being separated from the tubes  $f$  by spaces 10, through which the products of combustion may pass from the furnace into the spaces or flues outside of the tubes  $f$ , the tubes  $f^4$  arranged to form outer closed walls separated  
 15 from the tubes  $f$  by intervening spaces or flues, the separated tubes  $f^5$  in said flues, and the smoke-stack arranged over the forward end of the furnace and communicating with said intermediate spaces or flues through  
 20 openings between the tubes composing the upper walls of said flues, whereby the products of combustion, after passing from the front portion of the furnace backwardly along the wall formed by the tubes  $f$ , are caused to pass  
 25 in the reverse direction through the said intermediate flues, as set forth.

4. In a steam-generator, the combination of the water-drums arranged at opposite sides of the grate, the steam-drums arranged over  
 30 said water-drums, the tubes  $f f'$ , connecting the water and steam drums and arranged to constitute a closed inner wall extending from the front partly to the rear end of the furnace, the tubes  $f'$  alternating with the tubes  $f$  near  
 35 the rear portion of the furnace, said tubes  $f'$  being separated from the tubes  $f$  by spaces 10, through which the products of combustion may pass from the furnace into the flues outside of the tubes  $f$ , the tubes  $f^4$ , arranged to

form outer closed walls separated from the 40 tubes  $f$  by intervening spaces or flues, the separated tubes  $f^5$  in said flues, the smoke-stack arranged over the forward end of the furnace and communicating with said intermediate flues through openings between the 45 tubes composing the upper walls of said flues, and the baffle-plate or deflector  $h$ , arranged to cause a downward movement of the products of combustion before the latter enters the smoke-stack, as set forth. 50

5. In a steam-generator, the combination of the outside water-drums  $a a$ , arranged at the outer sides of the furnace, the intermediate water-drum  $a'$ , arranged at the center of the furnace, the two steam-drums arranged 55 over the drums  $a a$ , and the bent generating-tubes connecting the drums  $a a'$  with the steam-drums, as set forth.

6. In a steam-generator, the combination of the outside water-drums  $a a$ , the intermediate water-drum  $a'$ , the transverse connecting-pipes  $a''$ , the steam-drums arranged over the water-drums  $a a$ , and the generating-tubes  $f, f', f^2, f^3, f^4$ , and  $f^5$ , arranged as described, and 65 connecting the water-drums and the connecting-pipes with the steam-drums, the tubes  $f^2$  being arranged at the center and the tubes  $f^3$  being arranged at the ends of the grate, as set forth.

In testimony whereof I have signed my 70 name to this specification, in the presence of two subscribing witnesses, this 10th day of March, A. D. 1890.

CHARLES D. MOSHER.

Witnesses:

A. D. HARRISON,

ARTHUR W. CROSSLEY.